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UNITED STATES DEPARTMENT OF AGRICULTURE

A Practical Seed-Cotton Moisture Tester for Use at Gins

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NEED FOR A SEED-COTTON MOISTURE TESTER AT COTTON GINS

For many years, the cotton-ginning industry has been aware, in a general way, of the operating difficulties and economic losses accompanying the ginning of green, dew-laden, damp, or wet seed cotton. Results of recent studies and tests [2] conducted at the United States Cotton Ginning Laboratory have proved conclusively that the amount of moisture in seed cotton is one of the most important factors affecting gin operation, the efficiency of the ginning process, and the resulting quality of the ginned lint. More precisely, if seed cotton is too damp to permit good ginning, the grower of the cotton suffers a loss as a result of a lowering of certain elements of quality in the ginned lint.

The use of the cotton drier for artificially drying seed cotton before ginning has been of distinct aid in conditioning damp seed cotton to facilitate proper ginning and to enhance the value of the lint obtained

[1] Acknowledgment is made to Francis L. Gerdes, senior cotton technologist, Agricultural Marketing Service, under whose immediate supervision the developmental and research work herein reported was done, and to Charles A. Bennett, senior mechanical engineer, Bureau of Agricultural Chemistry and Engineering, as well as to other staff members of both agencies at the U. S. Cotton Ginning Laboratory, for suggestions and assistance.

[2] Gerdes, Francis L., and Bennett, Charles A. effect of artificially drying seed cotton before ginning on certain quality elements of the lint and seed and on the operation of the gin stand. U. S. Dept. Agr. Tech. Bul. 508, 62 pp., illus. 1936.

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from such cotton. The operation of a cotton drier in such a way as to produce the best drying effects, however, is dependent to a considerable degree upon the control of air temperatures in relation to the amount of moisture in the seed cotton at time of ginning.[3]

On the basis of results obtained in many ginning tests conducted at the United States Cotton Ginning Laboratory, some general limits of moisture content required for good ginning results have been established. It has been ascertained that, with short-staple cotton (staple length shorter than 1⅛ inches), drying either artificially or naturally is usually necessary when the moisture content of the seed cotton is 12 percent or more, if damage to the lint quality during ginning is to be avoided. Drying of long-staple varieties is generally necessary if the moisture content of the seed cotton is 10 percent or more. It is seldom that cottons with a moisture content of less than the limits cited will show improvement in preparation or smoothness of sample solely as a result of moisture removal when passed through a drier prior to ginning. But some cleaning benefits do result when such cottons are so handled, even without application of heat.

Precise information as to the range in moisture conditions prevailing in a load of seed cotton, which may vary considerably at different levels and locations throughout the load, is advantageous to the ginner in promoting more efficient drying and ginning of those seed cottons that have a moisture content in excess of the limits required for best ginning results. At gins that have considerable volumes of cotton for daily ginning, for example, it would be desirable to have available a rapid and practicable method of determining the moisture content of all loads of seed cotton upon arrival at the gin yard, so that the cotton to be ginned could be segregated into groups according to the degree of dampness or the amount of moisture it contained. Such a procedure would reduce to a minimum the time, effort, and expense necessary to make such adjustments of the drier and ginning equipment as are required for the best ginning performance.

At present, the decision as to whether seed cotton needs drying before ginning, the correct operation of the cotton drier, and the regulation of the gin feed while ginning, are dependent principally upon the skill of the ginner in judging the moisture content of the seed cotton by touch of the hand and by general appearance of the material. When, however, seed cotton is arbitrarily classified as being "dry," "damp," or "wet," on the basis of the hand-contact method, the classification by each ginner covers a broad range of moisture content for each group designation, the moisture contents of the different groups frequently overlap, and the meaning of the moisture designations varies among different ginners. This method, therefore, does not and cannot yield estimates of the moisture of seed cotton with the accuracy and uniformity needed for best drying and ginning results.

The usual laboratory or oven-drying method of determining the moisture content of representative samples of a load of seed cotton brought to the gin by wagon or truck is not adapted to give the rapid results needed by a commercial cotton gin in its daily and seasonal operations. The lack of a simple and rapid method of determining the moisture content of seed cotton prior to ginning has been and still is a handicap

[3] GERDES, FRANCIS L., MARTIN, WILLIAM J., and BENNETT, CHARLES A. DRYING SEED COTTON. U. S. Dept. Agr. Leaflet 181, 8 pp., illus. [1939.]

to ginners interested in producing quality ginning throughout the season.

To this end, therefore, considerable research and developmental work has been done over a period of years at the United States Cotton Ginning Laboratory in an effort to develop a simple, durable, inexpensive, and practical seed-cotton moisture tester especially designed for use by ginners in conjunction with cotton driers. The apparatus and method here described are the result of those studies and constitute, it is felt, definite progress towards the ultimate goal.

BASIS FOR DEVELOPMENT OF THE MOISTURE TESTER

Preliminary experiments started in 1932 have led to the development of a relatively simple apparatus for determining the moisture content of seed cotton by measuring the hygrometric condition, or degree of dampness, of the air confined inside a mass of seed cotton.[4] The principle made use of and the method employed are based on the tendency of hygroscopic or moisture-absorbent materials such as cotton fibers to gain or lose moisture quite rapidly until a state of approximate equilibrium obtains between the moisture content of the material and that of its surrounding atmosphere.[5] This property depends upon the initial moisture content of the materials and the relative humidity of the atmosphere surrounding them. In the case of seed cotton, it is generally the degree of dampness or moisture content of the fibers attached to the seed at the time of ginning rather than the relatively stable moisture content of the seed that materially influences the settings, operation, and efficiency of drying and ginning equipment. Thus a knowledge of the relative humidity of the air confined within the mass of seed cotton furnishes an index of the moisture condition of the seed cotton and is of practical application in promoting good-quality ginning.

Investigations and tests conducted with various types of instruments for measuring the relative humidity of air have indicated that the simplest and most reliable type thus far available for use in a seed cotton moisture-testing apparatus is the psychrometer, which employs two matched thermometers,—one plain and one with a wet-bulb covering—for simultaneously indicating the dry-bulb and wet-bulb temperatures of the atmosphere.[6]

Relative humidity is defined as the part or fraction of invisible water, in the form of vapor, actually present in air as compared with the maximum amount the air can hold at a given temperature and atmospheric pressure, without the water vapor condensing into droplets. This fraction is usually expressed as percentage. For example, when the air is saturated with water vapor, its humidity is said to be 100 percent: if it contains three-fourths as much, its humidity is 75 percent; etc.

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[4] GAUS, GEORGE E., and BENNETT, CHARLES A. APPARATUS FOR DETERMINING THE MOISTURE CONTENT OF AIR PERVADING FIBROUS MATERIAL. (U. S. Patent No. 2,151,404) U. S. Patent Office Off. Gaz. 500: 667–668, illus. 1939.

[5] AHMAD NAZIR. VARIATION IN THE MOISTURE CONTENT OF BALED INDIAN COTTON WITH ATMOSPHERIC HUMIDITY. Indian Cent. Cotton Com., Bombay, Technol. Lab., Technol. Bul. (ser. A) 23, 34 pp., illus. 1933.

MASSON, ORME, and RICHARDS, E. S. ON THE HYGROSCOPIC ACTION OF COTTON. Royal Soc. London, Proc. Ser. A, 78: 412–429, illus. 1906.

[6] MARVIN, C. F. PSYCHROMETRIC TABLES FOR OBTAINING THE VAPOR PRESSURE, RELATIVE HUMIDITY, AND TEMPERATURE OF THE DEW-POINT FROM READINGS OF THE WET AND DRY BULB THERMOMETERS. U. S. Weather Bureau WB–235, 87 pp., illus. 1915.

The relative humidity of air at a prevailing temperature can be ascertained from the difference between the indicated temperatures of the wet-bulb and dry-bulb thermometers of the moisture tester and the values shown in table 1. Although this table is computed only for an atmospheric pressure comparable with a barometric reading of 30 inches of mercury, it may be used in general for all practical purposes.

The lower temperature—that of the wet-bulb as compared with that of the dry-bulb thermometer—is due to cooling consequent upon the evaporation of water from the moist wick. The less water vapor there is in the air at a given temperature, the greater is the capacity of the air to absorb additional moisture. The extent to which the reading of the wet-bulb is lower than that of the dry-bulb thermometer, is an indication of the relative saturation of the air surrounding the two thermometers. On the basis of this difference between thermometer readings, frequently referred to as the "depression of the wet bulb," table 1 has been constructed.

TABLE 1.—*Humidity table for use with moisture tester for seed cotton (relative humidity at specified dry-bulb readings and specified differences between dry-bulb and wet-bulb reading at barometric pressure of 30 inches)*[1]

Dry-bulb reading (° F.)	Humidity when difference between temperature readings of wet-bulb and dry-bulb thermometers is—																			
	1° F.	2° F.	3° F.	4° F.	5° F.	6° F.	7° F.	8° F.	9° F.	10° F.	11° F.	12° F.	13° F.	14° F.	15° F.	16° F.	17° F.	18° F.	19° F.	20° F.
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
35	91	81	72	63	54	45	36	27	19	10	2	----	----	----	----	----	----	----	----	----
36	91	82	73	64	55	46	38	29	21	13	5	----	----	----	----	----	----	----	----	----
37	91	83	74	65	57	48	40	31	23	15	7	----	----	----	----	----	----	----	----	----
38	91	83	75	66	58	50	42	33	25	17	10	2	----	----	----	----	----	----	----	----
39	92	83	75	67	59	51	43	35	27	20	12	5	----	----	----	----	----	----	----	----
40	92	83	75	68	60	52	45	37	29	22	15	7	0	----	----	----	----	----	----	----
41	92	84	76	69	61	54	46	39	31	24	17	10	3	----	----	----	----	----	----	----
42	92	85	77	69	62	55	47	40	33	26	19	12	5	----	----	----	----	----	----	----
43	92	85	77	70	63	55	48	42	35	28	21	14	8	1	----	----	----	----	----	----
44	93	85	78	71	63	56	49	43	36	30	23	16	10	4	----	----	----	----	----	----
45	93	86	78	71	64	57	51	44	38	31	25	18	12	6	----	----	----	----	----	----
46	93	86	79	72	65	58	52	45	39	32	26	20	14	8	2	----	----	----	----	----
47	93	86	79	72	66	59	53	46	40	34	28	22	16	10	5	----	----	----	----	----
48	93	86	79	73	66	60	54	47	41	35	29	23	18	12	7	1	----	----	----	----
49	93	86	80	73	67	61	54	48	42	36	31	25	19	14	9	3	----	----	----	----
50	93	87	80	74	67	61	55	49	43	38	32	27	21	16	10	5	----	----	----	----
51	94	87	81	75	68	62	56	50	45	39	34	28	23	17	12	7	2	----	----	----
52	94	87	81	75	69	63	57	51	46	40	35	29	24	19	14	9	4	----	----	----
53	94	87	81	75	69	63	58	52	47	41	36	31	26	20	16	10	6	1	----	----
54	94	88	82	76	70	64	59	53	48	42	37	32	27	22	17	12	8	3	----	----
55	94	88	82	76	70	65	59	54	49	43	38	33	28	23	19	14	9	5	----	----
56	94	88	82	76	71	65	60	55	50	44	39	34	30	25	20	16	11	7	2	----
57	94	88	82	77	71	66	61	55	50	45	40	35	31	26	22	17	13	8	4	----
58	94	88	83	77	72	66	61	56	51	46	41	37	32	27	23	18	14	10	6	1
59	94	89	83	78	72	67	62	57	52	47	42	38	33	29	24	20	16	11	7	3
60	94	89	83	78	73	68	63	58	53	48	43	39	34	30	26	21	17	13	9	5
61	94	89	84	78	73	68	63	58	54	49	44	40	35	31	27	22	18	14	10	7
62	94	89	84	79	74	69	64	59	54	50	45	41	36	32	28	24	20	16	12	8
63	95	89	84	79	74	69	64	60	55	50	46	42	37	33	29	25	21	17	13	10
64	95	90	84	79	74	70	65	60	56	51	47	43	38	34	30	26	22	18	15	11
65	95	90	85	80	75	70	66	61	56	52	48	44	39	35	31	27	24	20	16	12
66	95	90	85	80	75	71	66	61	57	53	48	44	40	36	32	29	25	21	17	14
67	95	90	85	80	75	71	66	62	58	53	49	45	41	37	33	30	26	22	19	15
68	95	90	85	80	76	71	67	62	58	54	50	46	42	38	34	31	27	23	20	16
69	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	32	28	24	21	18
70	95	90	86	81	77	72	68	64	59	55	51	48	44	40	36	33	29	25	22	19
71	95	90	86	81	77	72	68	64	60	56	52	48	45	41	37	33	30	27	23	20
72	95	91	86	82	77	73	69	65	61	57	53	49	45	42	38	34	31	28	24	21
73	95	91	86	82	78	73	69	65	61	57	53	50	46	42	39	35	32	29	25	22
74	95	91	86	82	78	74	69	65	61	58	54	50	47	43	39	36	33	29	26	23

[1] Compiled from data issued by the U. S. Weather Bureau.

TABLE 1.—*Humidity table for use with moisture tester for seed cotton (relative humidity at specified dry-bulb readings and specified differences between dry-bulb and wet-bulb readings of barometric pressure of 30 inches)*—Continued

Dry-bulb reading (° F.)	Humidity when difference between temperature readings of wet-bulb and dry-bulb thermometers is—																			
	1° F.	2° F.	3° F.	4° F.	5° F.	6° F.	7° F.	8° F.	9° F.	10° F.	11° F.	12° F.	13° F.	14° F.	15° F.	16° F.	17° F.	18° F.	19° F.	20° F.
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
75	96	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	30	27	24
76	96	91	87	82	78	74	70	66	62	59	55	51	48	44	41	38	34	31	28	25
77	96	91	87	83	79	74	71	67	63	59	56	52	48	45	42	39	35	32	29	26
78	96	91	87	83	79	75	71	67	63	60	56	53	49	46	43	39	36	33	30	27
79	96	91	87	83	79	75	71	68	64	60	57	53	50	46	43	40	37	34	31	28
80	96	91	87	83	79	75	72	68	64	61	57	54	50	47	44	41	38	35	32	29
82	96	92	88	84	80	76	72	69	65	61	58	55	51	48	45	42	39	36	33	30
84	96	92	88	84	80	76	73	69	66	62	59	56	52	49	46	43	40	37	35	32
86	96	92	88	84	81	77	73	70	66	63	60	57	53	50	47	44	42	39	36	33
88	96	92	88	85	81	77	74	70	67	64	61	57	54	51	48	46	43	40	37	35
90	96	92	89	85	81	78	74	71	68	65	61	58	55	52	49	47	44	41	39	36
92	96	92	89	85	82	78	75	72	68	65	62	59	56	53	50	48	45	42	40	37
94	96	93	89	85	82	79	75	72	69	66	63	60	57	54	51	49	46	43	41	38
96	96	93	89	86	82	79	76	73	69	66	63	61	58	55	52	50	47	44	42	39
98	96	93	89	86	83	79	76	73	70	67	64	61	58	56	53	50	48	45	43	40
100	96	93	89	86	83	80	77	73	70	68	65	62	59	56	54	51	49	46	44	41
102	96	93	90	86	83	80	77	74	71	68	65	62	60	57	55	52	49	47	45	42
104	97	93	90	87	83	80	77	74	71	69	66	63	60	58	55	53	50	48	46	43
106	97	93	90	87	84	81	78	75	72	69	66	64	61	58	56	53	51	49	46	44
108	97	93	90	87	84	81	78	75	72	70	67	64	62	59	57	54	52	49	47	45
110	97	93	90	87	84	81	78	75	73	70	67	65	62	60	57	55	52	50	48	46
112	97	94	90	87	84	81	79	76	73	70	68	65	63	60	58	55	53	51	49	47
114	97	94	91	88	85	82	79	76	74	71	68	66	63	61	58	56	54	52	49	47
116	97	94	91	88	85	82	79	76	74	71	69	66	64	61	59	57	54	52	50	48
118	97	94	91	88	85	82	79	77	74	72	69	67	64	62	59	57	55	53	51	49
120	97	94	91	88	85	82	80	77	74	72	69	67	65	62	60	58	55	53	51	49
122	97	94	91	88	85	83	80	77	75	72	70	67	65	63	60	58	56	54	52	50
124	97	94	91	88	85	83	80	78	75	73	70	68	65	63	61	59	57	54	52	50
126	97	94	91	88	86	83	80	78	75	73	70	68	66	64	61	59	57	55	53	51
128	97	94	91	89	86	83	81	78	76	73	71	68	66	64	62	60	58	56	54	52
130	97	94	91	89	86	83	81	78	76	73	71	69	67	64	62	60	58	56	54	52

MOISTURE TESTER DEVELOPED AT THE UNITED STATES COTTON GINNING LABORATORY

The relative humidity of the air drawn from within a mass of seed cotton and passed over the two thermometers may be determined with the moisture tester described in this circular. The tester, illustrated in figure 1, is so designed that the perforated tube, *a*, may be inserted in the mass of seed cotton under test. The motor-driven fan, *c*, withdraws the moisture-laden air from the interior of the mass of seed cotton and pulls this air over the wet-bulb and dry-bulb thermometers, *b*. The metallic tube for insertion in the mass of seed cotton to be tested is provided with a bullet-shaped head and a series of perforations, of small diameter, located near the head of the tube. The opposite end of the perforated tube is connected to a chamber housing the bulbs of the thermometers. The rear outlet of the chamber is provided with a section of flexible hose for the attachment of a small, hand-type vacuum cleaner without dust bag.

Detailed specifications and bills of material for the construction of each of several types of moisture testers and of a moisture content calculator are presented in this publication, and figures 1 to 12, inclusive, illustrate the construction and use of the various devices. The estimated cost of construction, materials, and supplementary apparatus required for each type of moisture tester is approximately $25. Variations in local prices of materials, however, will influence appreciably the total cost of the completed devices.

DIRECTIONS FOR USE OF THE MOISTURE TESTER

The absorbent wick surrounding the bulb of the wet-bulb thermometer of the moisture tester must be thoroughly saturated with clean

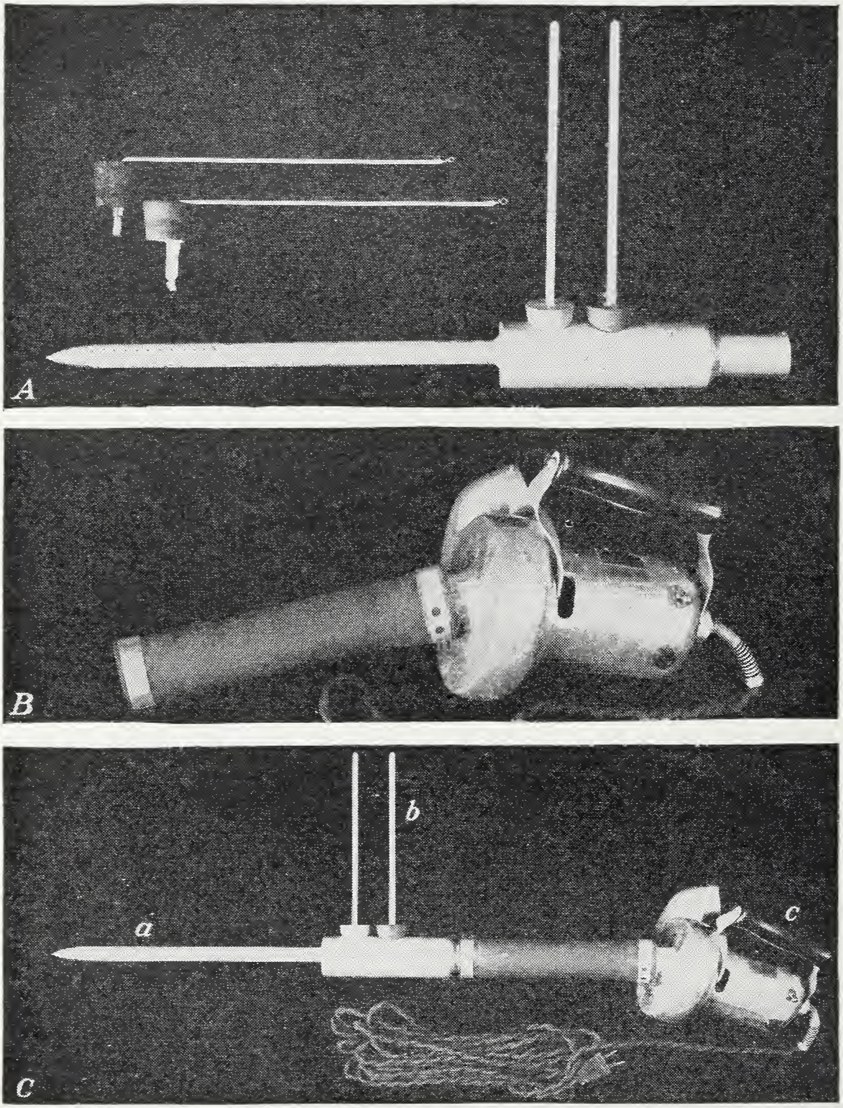

FIGURE 1.—*A*. Psychrometric moisture tester for the determination of moisture content of seed cotton, equipped with straight-stem thermometers. The bent-stem thermometers illustrated can be used. *B*. Vacuum-cleaner motor and attachment hose for withdrawing moisture-laden air through the moisture tester. *C*. Moisture tester and vacuum cleaner operatively assembled: *a*, the perforated tube; *b*, the two thermometers; *c*, the motor-driven fan.

water before each moisture determination is made. The types of testers equipped with a water reservoir eliminate the necessity of wetting the wick between each moisture determination. The dry-bulb thermometer should be located in the opening of the housing nearest the perforated tube.

The procedure to be followed in making a moisture determination is to insert the full length of the perforated tube into the mass of seed cotton to be tested, as shown in figure 2. The vacuum cleaner attached to the outlet end of the tester is then set in operation. The suction created by the vacuum cleaner causes the moisture-laden air pervading the locks of seed cotton surrounding the tube, to enter the perforations of the tube and to be drawn past the dry-bulb and wet-bulb thermometers that are housed in the body of the tester.

The circulation of the air through the tester is continued until the respective temperature indications of the dry-bulb and wet-bulb thermometers become constant. At the moment when this condition occurs, usually within the first 2 or 3 minutes of testing, the temperature readings of both thermometers should be recorded.

From the simultaneous readings recorded for the dry-bulb and wet-bulb temperatures, the relative humidity of the air confined in the seed cotton is ascertained by referring to the data shown in table 1. And, from the relative humidity so obtained, the equivalent moisture content of the seed cotton is read directly from the conversion figures presented in table 2.

TABLE 2.—*Conversion table for use with seed-cotton moisture tester*[1]

Relative humidity of air confined in seed cotton (percent)	Corresponding moisture content of seed cotton	Relative humidity of air confined in seed cotton (percent)	Corresponding moisture content of seed cotton	Relative humidity of air confined in seed cotton (percent)	Corresponding moisture content of seed cotton
	Percent		*Percent*		*Percent*
41	6.2	61	9.0	81	14.5
42	6.3	62	9.2	82	14.9
43	6.4	63	9.5	83	15.3
44	6.5	64	9.7	84	15.6
45	6.6	65	9.9	85	16.1
46	6.7	66	10.1	86	16.5
47	6.9	67	10.3	87	17.0
48	7.0	68	10.6	88	17.4
49	7.1	69	10.8	89	17.9
50	7.3	70	11.0	90	18.4
51	7.4	71	11.3	91	18.9
52	7.5	72	11.6	92	19.5
53	7.7	73	11.9	93	20.0
54	7.8	74	12.1	94	20.6
55	8.0	75	12.5	95	21.2
56	8.2	76	12.7	96	21.8
57	8.3	77	13.1	97	22.5
58	8.5	78	13.4	98	23.1
59	8.7	79	13.8	99	23.8
60	8.9	80	14.1	100	24.6

[1] This conversion table is based on data compiled from a large number of tests conducted on many seed cottons obtained throughout the cotton-harvesting and ginning seasons from 1936 to 1939 and representing a wide range in moisture content. Comparative tests were made on each lot of cotton by means of the moisture tester and by the usual laboratory oven-drying method. An analysis of the data obtained by the two methods has revealed a coefficient of correlation of 0.94 and a standard error of estimate of 1.48 percent. The relationship between moisture content of seed cotton and relative humidity of the air pervading the mass has been found to follow, for all practical purposes, a semilogarithmic curve. On the basis of this curve, the figures shown in the conversion table have been tabulated. This table has not been corrected for a slight effect of extreme temperature range at constant relative humidity on the corresponding moisture content of cotton. The excessive moisture conditions affecting the ginning of seed cotton correspond to a narrow range of relative humidity, and within this range the table is sufficiently accurate for use with the moisture tester.

As an example: if the dry-bulb thermometer reads 90° F. and the wet-bulb thermometer reads 85°, there is a difference of 5°. Re-

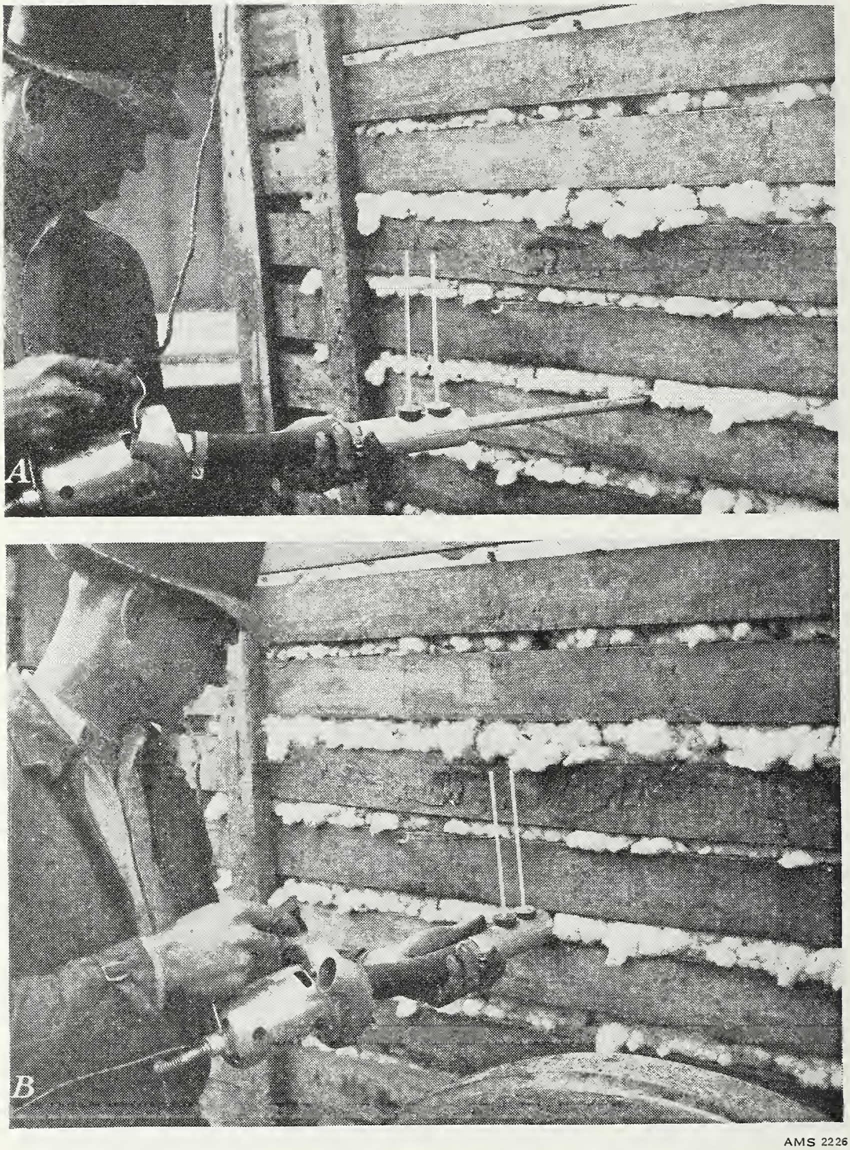

FIGURE 2.—Method of use of psychrometric moisture tester in determining moisture content of a wagonload of seed cotton: *A*, Tester in position to insert perforated tube into the cotton; *B*, tester in operation and thermometer readings being observed.

ferring to table 1, first column, identified as "Dry-bulb reading (° F.)," read down the column until figure 90 is reached. Then read along this horizontal line to the right until the column identified as

5° F., representing the difference between dry-bulb and wet-bulb thermometers is reached. Here will be found the figure of 81 which means that the relative humidity involved in this test is 81 percent. Referring to table 2, it will be seen that 81 percent relative humidity of the air confined in the seed cotton corresponds to 14.5 percent moisture content of seed cotton.

Although the method described for determining the moisture content of seed cotton is relatively simple, certain precautions should be observed in conducting the tests.

In order to obtain a representative indication of the moisture content of seed cotton in bulk lots, such as a wagonload, it is necessary that more than one test be made throughout the mass of material. It has been found that tests at three locations (upper, central, and lower portions of a load of seed cotton) are usually sufficiently representative to ascertain the moisture condition of the load for the purpose of ginning. If, however, a wide variation in moisture content is found to exist among the three test locations, it will be desirable to make tests at additional locations. The upper test location of the load should be 12 to 18 inches below the surface of the seed cotton in order to avoid drawing air from the upper layers of seed cotton which have been exposed to the drying action of sun and air.

Care should be used when inserting the perforated tube into the seed cotton to prevent the formation of a large opening through which outside air may be drawn into the tester, as this would give inaccurate results.

If the tester is allowed to operate in a mass of seed cotton for a prolonged period before the temperature of the wet-bulb thermometer is read, outside air may be drawn through the cotton to such an extent as to alter the moisture content in the cotton immediately surrounding the tester and to give erroneous results for the mass.

During operation of the tester, the wet-bulb temperature reading normally should be 1 or more degrees below the reading of the dry-bulb temperature. If a difference of less than 1° is observed, it is possibly the result of an improper condition of the wick surrounding the wet bulb owing to one of several causes.

The wet-bulb temperature reading should be constant at its lowest value for several minutes; if it rises immediately after indicating the low, the wick is probably dry and the temperature reading will be inaccurate. Insufficient moisture around the wick of the wet-bulb thermometer during the operation of the tester, for any reason, will result in an erroneously high temperature reading of the wet-bulb thermometer and a consequent error in the calculated moisture content percentage.

The wick of the wet-bulb thermometer should be examined frequently for conditions which may prevent rapid absorption of water, such as an incrustation or lodgment of foreign matter that would interfere with the normal rate of evaporation of water from the surface of the wick. For best results, frequent washing and occasional renewal of the wick are recommended. Water containing excessive minerals should not be used on the wick; ordinary drinking water or rain water, however, is satisfactory. Prolonged operation of the vacuum cleaner after the maximum drop in temperature of the wet

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bulb is attained, will cause a drying of the wick on the testers not equipped with water reservoirs.

Tests should not be made in direct sunlight without providing adequate shade for the tester. Otherwise the reading of the dry-bulb thermometer may be affected.

A longer period of operation of the tester is required at relatively low air temperatures because of a decrease in the rate of evaporation of water from the wick.

In order to assure the passage of a sufficient volume of air through the tester when moisture determinations are made, frequent inspection of the tester is necessary and the perforations of the intake tube should be kept completely open.

CALCULATOR FOR DETERMINING MOISTURE CONTENT OF SEED COTTON FROM WET-BULB AND DRY-BULB THERMOMETER READINGS

To facilitate an easy and quick determination of the moisture content of seed cotton from wet-bulb and dry-bulb thermometer readings of the tester, a calculator consisting of a set of integrating scales has been devised so that, by sliding or rotating a center temperature-reading scale between the outer immovable moisture-reading scales, the existing percentage of moisture is directly indicated.

The calculator scales have been developed from the data presented in tables 1 and 2 and are based on the maximum moisture content of 24.6 percent which was found for seed cotton at a relative humidity of 100 percent. These calculator scales are illustrated in figures 11 and 12.

The calculator is operated as follows: The center temperature scale is rotated so that the observed dry-bulb thermometer reading on this scale is brought directly opposite one of the index points DB (dry bulb), on one of the outer immovable moisture-content scales. At this setting, the figure on the center scale corresponding to the observed wet-bulb reading will indicate on the outer moisture scale the percent moisture content of the seed cotton being tested. For example: If the dry-bulb temperature reading were 75° F., the scale would be set as shown in the upper illustration of figure 11. Then, if the wet-bulb temperature reading were 70° F., the opposite figure on the outer scale, when read to the nearest moisture-scale graduation, would show a moisture content of 13.5 percent for the sample.

Certain ranges of the moisture scale are printed in colors, for rapid and convenient interpretation of the results in terms of recommended ranges of operating temperatures for cotton driers. Readings are made directly in terms of the most desirable drier-operating conditions. The blue, white, and red ranges correspond to dry, damp, and wet cotton, respectively, and the approximate operating temperature of the drier for each of those moisture conditions of the seed cotton is indicated in the legend under the scale.

The moisture tester, conversion chart, and calculator scales have been developed in connection with seed cotton and are intended for use only with seed cotton in bulk. In their present form, these devices are not adapted for use with lint cotton or cotton linters, either in bale or in loose form, or with cotton seed.

GENERAL INFORMATION ON CONSTRUCTION OF THE MOISTURE TESTERS

The construction of the moisture tester illustrated in figures 1 and 2, as a one-piece assembly of the air intake tube, thermometer housing, and air outlet, requires the facilities of a machine shop.

The moisture testers illustrated in figures 3 to 6, assembled with pipe fittings, can be constructed usually with the tools and shop

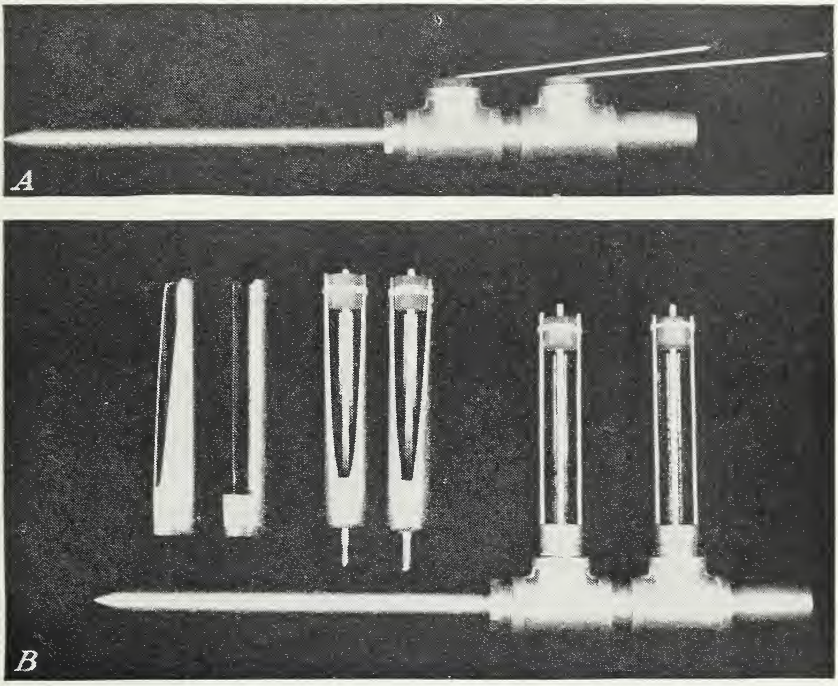


FIGURE 3.—*A*, Psychrometric moisture tester constructed of pipe fittings and equipped with mercury, bent-stem, glass thermometers for the determination of moisture content of seed cotton. *B*, Moisture tester with fittings for protection in use of mercury, straight-stem, glass thermometers.

equipment that are on hand at gin plants for use in the maintenance of the ginning equipment.

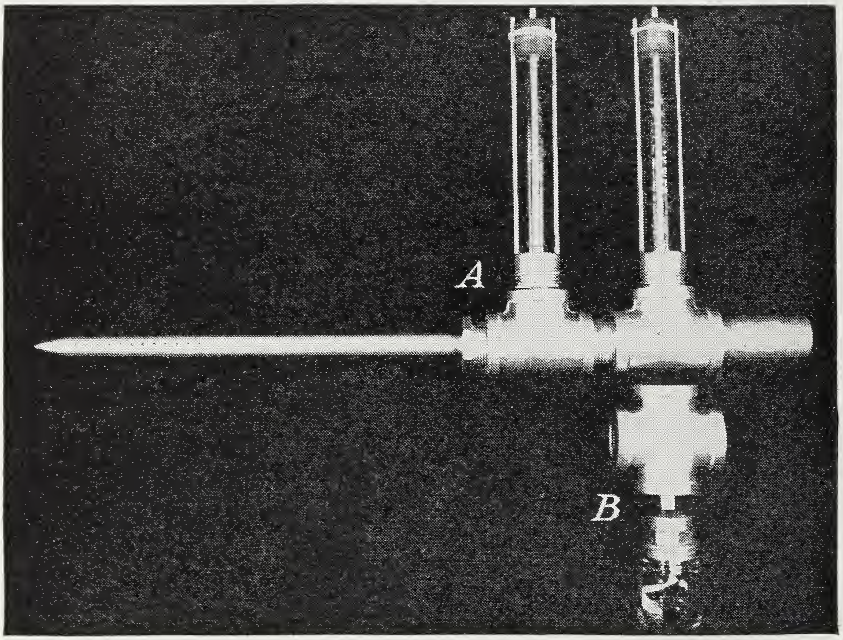
The prescribed dimensions and arrangement of the parts should be followed in the construction of the moisture testers. Deviations from these specifications may produce inaccurate results. Care should be exercised that no part of the thermometers is in direct contact with metal parts of the tester.

Thermometers should be obtained in accurately matched pairs, suitable for psychrometer use.

If the steel-stem, bimetallic, dial-indicating thermometers are used, not less than 4 inches of the lower portion of the thermometer stems should be exposed to the air circulated through the body of the tester.

The apparatus employed to create a suction of air through the moisture tester should develop a velocity of 10 to 15 feet per second of the air passing the bulbs of the thermometers when the moisture tester is in use.

The vacuum cleaner, or other air-suction apparatus, should be connected to the moisture tester in a manner that will prevent the conduction or radiation of heat from the air-suction apparatus to the body of the moisture tester. The flexible tubing used to connect the outlet of the tester to the air-suction means should be of length suffi-



AMS 2228

FIGURE 4.—Auxiliary fittings *B* needed when wet-bulb thermometer reservoir is used with moisture tester *A* illustrated in figure 3.

cient to prevent direct metal contact between the outlet of the tester and the intake of the suction apparatus.

The possible disturbing influence of sources of heat such as exposure in direct sunlight or manipulation by hand, on the operation of the tester can be reduced materially by covering the body or housing for the thermometers with several layers of insulating material, such as hair felt weather stripping, and then painting the tester with aluminum paint.

The dust bag should be removed from the hand-type vacuum cleaner as it induces a back pressure and a consequent reduction of velocity of the air passing through the moisture tester.

Tubular wicks (fig. 7, *D*) for the bulbs of the wet-bulb thermometers can be obtained from firms dealing in scientific apparatus and supplies. These wicks, however, are frequently too large to insure

the necessary close, smooth fit to the bulb and stem of the laboratory type of glass-stem thermometer. Satisfactory wicks for all types of thermometers can be made from loosely woven muslin that has been thoroughly washed with water to remove all sizing so far as possible. The muslin is cut wide enough to go about 1½ times around the thermometer bulb and stem. The muslin should first be thoroughly wetted with clean water, then neatly fitted around the thermometer. It

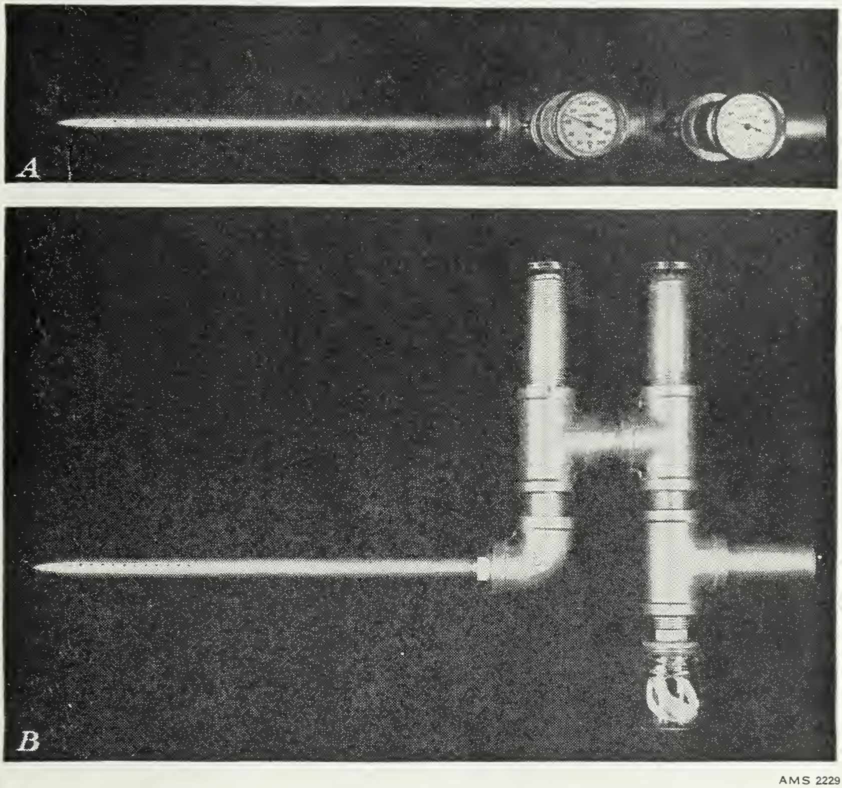


Figure 5.—*A*, Plan view of moisture tester for seed cotton. The tester is constructed of pipe fittings for the use of steel-stem, bimetallic, dial-type thermometers. *B*, Side view of the moisture tester.

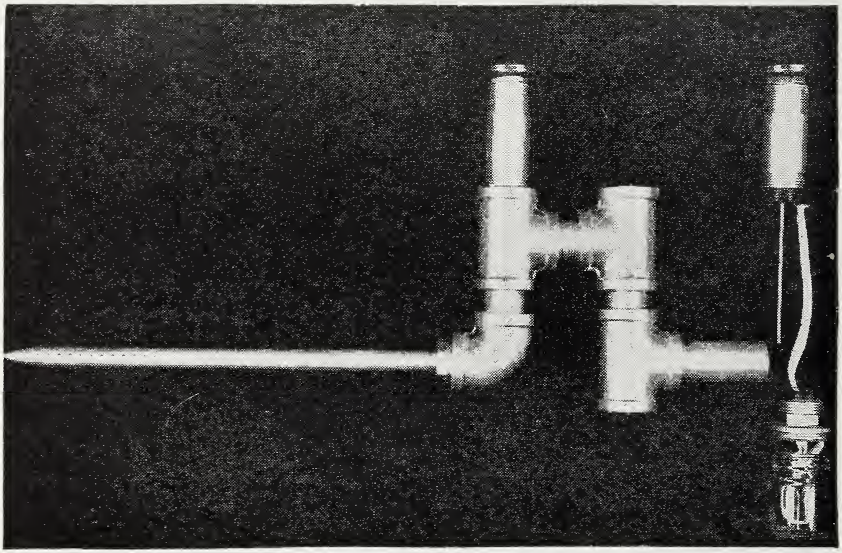
is tied first around the thermometer stem at the cork bushing, with a moderately strong thread. The tie at the end of the bulb of the thermometer stem is made by placing a loop of thread to form a knot around the bottom of the bulb just where it begins to round off. As this knot is drawn tight, the thread slips off the rounded end of the bulb and neatly stretches the muslin covering with it, and at the same time secures the wick at the bottom of the thermometer.

The wicks used with the types of moisture testers that are equipped with a water reservoir should be long enough to rest on the bottom of the reservoir jar. These long wicks should not be bound tightly at the lower end of the thermometer stem, as a restriction in the portion

of the wick below the end of the thermometer will interfere with the capillary function of the wick in conducting water throughout its length.

The tubular type of white shoelace, preferably of rayon or silk (fig. 7, *E*), will serve satisfactorily as a wick for either the steel-stem thermometers or the glass-stem thermometers when used with reservoir-equipped moisture testers. The shoelace is cut to the correct length, is drawn over the end of the thermometer, and is tied tightly to the thermometer stem at the cork bushing.

When using the type of moisture testers equipped with a water reservoir, it is advisable to permit a sufficient interval of time to elapse



AMS 2219

Figure 6.—Assembly details of wet-bulb thermometer and water reservoir for moisture tester illustrated in figure 5.

after the reservoir has been filled for thorough saturation of the wick by absorption of water.

Glass-stem thermometers encased in protective metal tubes or shields are obtainable. This armored type of thermometer, however, is not usually adapted to the proper functioning of the wet bulb.

There are available a number of direct-reading hygrometers having a scale on which the percentage of relative humidity is indicated. Most hygrometers of this type employ as the indicating medium a hygroscopic material, such as a hair, that changes in length with changes in humidity. These types of humidity indicators generally have an appreciable time lag, are of uncertain behavior if held at the higher humidities for a period of time, and when used in portable instruments usually require frequent check and adjustment under known conditions of humidity.

The materials needed for the construction of the various moisture testers and the moisture content calculator described herein, with the exception of the thermometers and manufactured wet-bulb wicks,

can usually be obtained from hardware firms or from mail-order firms. The various types of thermometers and the manufactured wet-bulb wicks can be obtained from scientific apparatus supply firms.

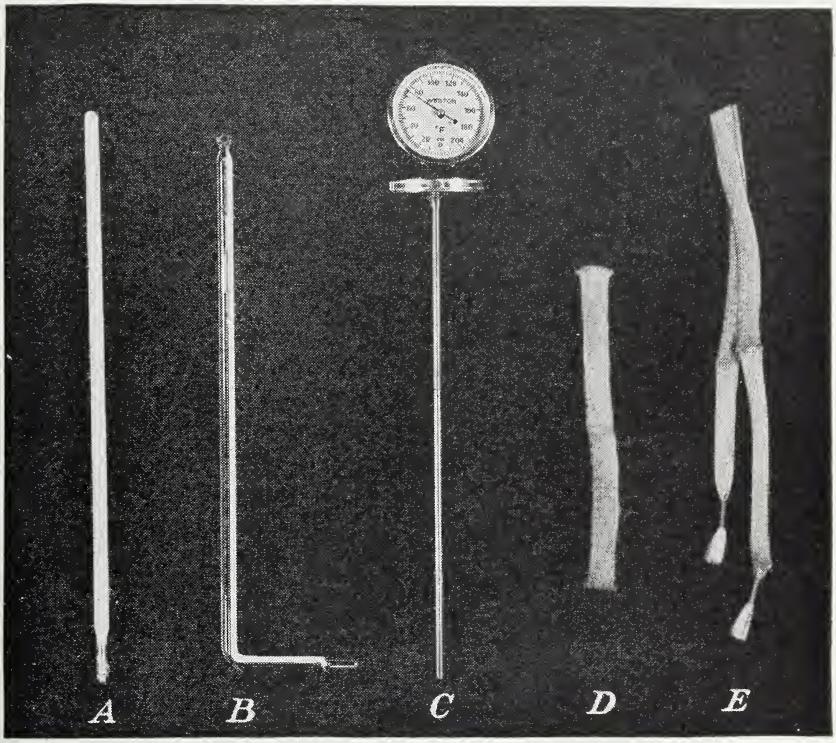


FIGURE 7.—Thermometers and wicks for use with moisture testers: *A*, Thermometer, sling-psychrometer type, mercury, straight-stem, glass, —40° to 120° F., 1° divisions; *B*, thermometer, mercury, bent-stem, glass, —10° to 130° F., 1° divisions; *C*, thermometer, steel-stem, dial-type, 8-inch stem, 0° to 180° F. or 220° F., 2° divisions; *D*, tubular wet-bulb thermometer wick, obtainable from firms dealing in scientific apparatus and supplies; *E*, white tubular shoelace which may be used as a wet-bulb wick.

SEED-COTTON MOISTURE TESTER (MACHINED ONE-PIECE ASSEMBLY) WITH MERCURY, GLASS-STEM THERMOMETERS

(Bill of Material, Specification for Construction and Assembly as Indicated on Drawing, p. 16, fig. 8)

ACCESSORIES

Quantity	*Article*
1 piece	Automobile-radiator hose, 1⅜ inches inside diameter by 6 inches in length.
2	Hose clamps, automobile-radiator hose.
2	Corks or rubber stoppers.

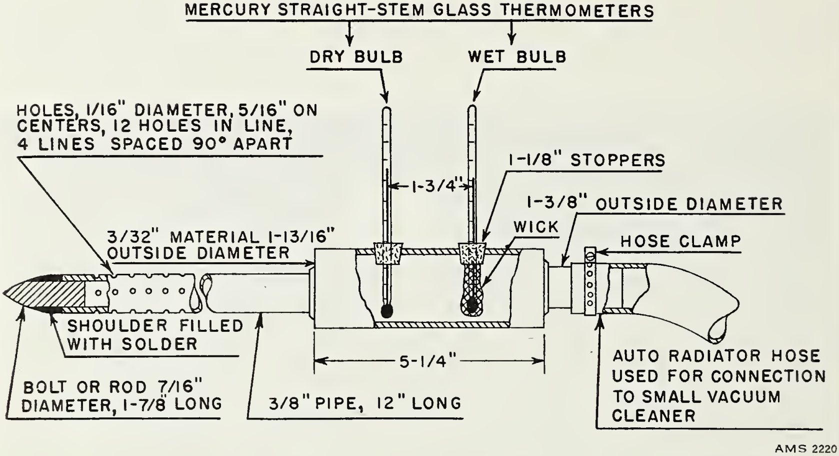


FIGURE 8.—Drawing of seed-cotton moisture tester illustrated in figure 1.

ACCESSORIES—continued

Quantity	*Article*
2	Thermometers, mercury, straight-stem, glass (sling-psychrometer type), temperature range —40° to 120° F. by 1° divisions; or mercury thermometers, glass stem, with right-angle bend 2 inches from end of bulb. The thermometers should be obtained in accurately matched pairs suitable for psychrometer use.
	Wicks for wet-bulb thermometer stem.
1	Vacuum cleaner, portable, hand-type.

SEED-COTTON MOISTURE TESTER CONSTRUCTED OF PIPE FITTINGS WITH PROVISION FOR PROTECTING MERCURY, STRAIGHT-STEM, GLASS THERMOMETERS (ILLUSTRATED IN FIGS. 3, 4, AND 9)

BILL OF MATERIAL

All pipe fittings to be either brass or malleable galvanized iron.

Quantity	*Article*	*Fig. 9, article No.*
1	⅜-inch pipe, 12 inches in length, only 1 end threaded	1
1	Machine bolt, 7/16 by 2½ inches, cut threads, or 7/16-inch diameter rod.	2
1	Shoulder bushing, 1 by ⅜ inch, or if not obtainable use the following size bushings for 3 reductions from 1-inch to ⅜-inch pipe size: 1 bushing, ½ by ⅜ inch. 1 bushing, ¾ by ½ inch. 1 bushing, 1 by ¾ inch.	

Bill of Material—Continued

Quantity	*Article*	*Fig. 9, article No.*
2	T's, 1 by 1 by 1 inch. If water reservoir is to be attached use the following:	4
	1 T, 1 by 1 by 1 inch.	
	1 cross, 1 by 1 by 1 by 1 inch	5
	1 shoulder bushing 1 by ¼ inch	6
	If this fitting is not obtainable substitute a 1- by ¼-inch square-head plug and drill a hole ¼ inch in diameter through the center of its head. (The use of separate bushings to secure a 4-step reduction from 1-inch to ¼-inch pipe would place the source of water supply for the wick at too great a distance below the end of the thermometer.)	
1	Close nipple, 1 inch, 1½ inches in length	7
1	Long nipple, 1 inch, 3 inches in length	8
2	Extra-long nipples, 1 inch, 8 inches in length	9

ACCESSORIES

	Solder	10
1 piece	Automobile-radiator hose, 1¼ inches (inside diameter) by 6 inches in length.	11
2	Hose clamps, automobile radiator hose	12
4	Corks or rubber stoppers	13
2	Thermometers, mercury, straight-stem, glass (sling psychrometer type), temperature range —40° to 120° F., by 1° divisions; or mercury thermometers with 2-inch bent-glass stems. The thermometers should be obtained in matched pairs.	14
	Wicks for wet-bulb thermometer stem	15
1	Small glass jar, with metal screw-cap closure	16
1	Vacuum cleaner, portable, hand-type.	

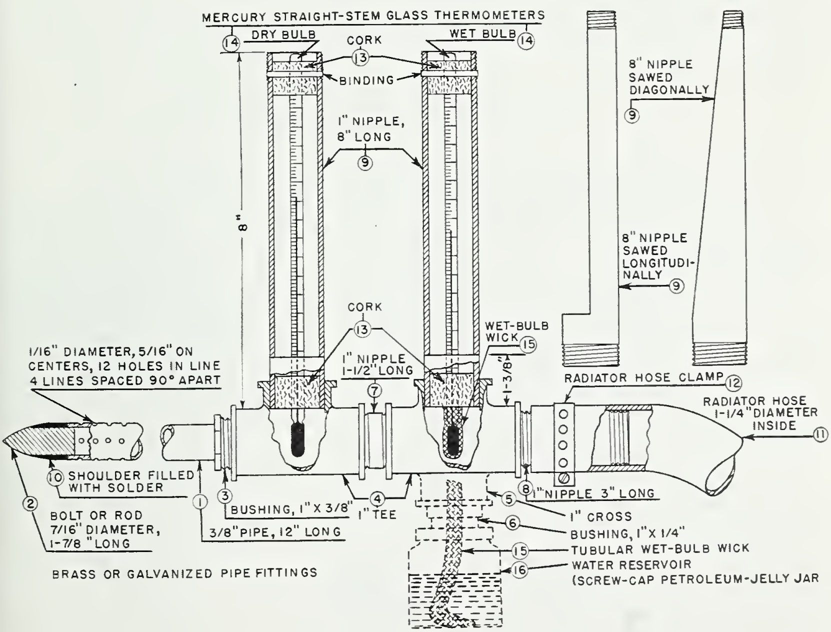


Figure 9.—Drawing of seed-cotton moisture tester illustrated in figures 3 and 4.

Specification for Construction and Assembly

AIR-INLET TUBE

A $\frac{7}{16}$-inch diameter machine bolt or a piece of $\frac{7}{16}$-inch diameter steel rod is used in forming the bullet-shaped penetrating tip. The over-all length of the solid tip is approximately $1\frac{7}{8}$ inches.

If a bolt is used, it should be cut off to leave approximately $\frac{3}{8}$ inch of threads at the end. The threaded end of the cut-off bolt should be filed or ground slightly tapered so that it can be driven into the unthreaded end of the 12-inch length of $\frac{3}{8}$-inch pipe. The threaded end of the bolt, or the length of rod, should be driven approximately three-eighths of an inch into the pipe. Care should be taken not to split the pipe in forcing the bolt or rod into the end of it. The end of the pipe surrounding the protruding portion of the cut-off bolt or rod should be filed or ground to a feather edge. The uneven surface or shoulder, between the end of the pipe and the bolt should be filled or built up with solder. The bolt and the end of the pipe should then be filed or ground to a bullet-shape, so that it may be easily inserted into the mass of seed cotton.

The air intake consists of four parallel lines of holes drilled on the side of the $\frac{3}{8}$-inch pipe and started close to the butt end of the solid tip. The 12 holes, $\frac{1}{16}$ of an inch in diameter, spaced five-sixteenths of an inch on centers, are drilled in line. The lines are spaced 90° apart. It is advisable to drill each of the 4 lines of holes separately since drilling through opposite sides of the pipe at one setting may cause the small $\frac{1}{16}$-inch diameter drill to break when starting through the underside of the pipe. The threaded end of the $\frac{3}{8}$-inch pipe is screwed tightly into the small opening of the 1 by $\frac{3}{8}$-inch bushing (fig. 9, article 3).

HOUSING FOR THERMOMETERS

Make airtight connections of the fittings numbered 3, 4, 7, 4, 8, and 9, in this order, illustrated in figure 9.

The two 8-inch long nipples (fittings 9) for protection of the glass straight-stem thermometers (article No. 14) are prepared in the following manner:

A cut is made across each nipple, $1\frac{3}{8}$ inches from its bottom and equal in depth to one-half the diameter of the nipple. The nipple is then sawed lengthwise from the top to the crosswise cut near the bottom, exposing a half-section of the interior of the nipple for a distance of $6\frac{5}{8}$ inches. The cut-away portion of the nipple affords support and protection to the glass-stem thermometers, which are held in place by cork bushings (article No. 13).

The nipples also may be cut diagonally from the center line at the top of the nipple to a point on the outer surface of the nipple $1\frac{3}{8}$ inches from the bottom. The diagonally sawed nipples afford greater protection to the thermometers, but they are more difficult to saw properly. The nipples should be screwed into the T's when laying off the saw lines, so that they will face the thermometers in the direction desired for convenience in reading. It is advisable to ream or

file the inner edges of all nipples so that the openings at the ends have the same diameter as the bore of the nipples.

The four cork bushings (article No. 13) are cut or filed for a snug fit in the 8-inch nipples housing the thermometers. The corks inserted in the lower ends of the nipples should be flush with the edges of the nipples. Each cork has a hole bored, drilled, or burned accurately through its center for the insertion of the stems of the thermometers. The thermometer stems should be passed through the holes in the corks without applying pressures great enough to break the stems. Wetting the thermometer stems with water before inserting them into the holes in the corks will aid their passage through the holes. If the holes in the cork are found to be oversize, lint cotton should be packed between the thermometer stems and corks to minimize leakage of air. The corks at the top of the nipples are split lengthwise through their centers for ease in positioning the thermometers and can be held in place by binding with wire, cord, or adhesive tape passed around the outside of the cork and the nipple. These corks should be of uniform diameter throughout so that no strain will fall on the thermometer stems when the corks are tied in place.

The thermometers should be secured in the corks so that the mercury bulbs are fully exposed and have approximately ¼-inch clearance at the bottom of the T's when the 8-inch nipples are attached to these T's.

The fittings should be assembled and screwed tight with a wrench. The two 8-inch-long nipples should then be disconnected for the insertion of the thermometers into the corks. Subsequent connection of these nipples to the moisture tester need not be tightened with a wrench as they should be disconnected frequently for inspection.

The thermometer housed in the nipple connected to the T nearest the tip of the moisture tester is designated the "Dry-bulb thermometer." The thermometer housed in the nipple connected to the second T is designated the "Wet-bulb thermometer."

PREPARATION OF THE WET-BULB THERMOMETER FOR USE

The wet-bulb thermometer is prepared for use in the following manner: The 8-inch long nipple housing the wet-bulb thermometer is disconnected from the T. A fine loosely woven muslin wick (article No. 15), approximately 1 inch longer than the exposed length of the thermometer stem and bulb, is smoothly fitted around the stem and is brought into contact with the cork bushing. The wick is then securely fastened to the thermometer stem by binding and tying with strong fine cotton or silk thread, close to the cork, at the bottom of the bulb, and at several places in between. The surplus portion of the wick below the mercury bulb is then cut off.

Bent-stem thermometers may be used in this tester by replacement of the 8-inch long nipples in the T's with the cork-bushed bent-stem thermometers.

WATER RESERVOIR (OPTIONAL)

A water-supply reservoir for the wet-bulb wick can be attached to this type of moisture tester by replacing the second T with a 1-inch cross (article No. 5).

The water reservoir is constructed in the following manner: A petroleum-jelly jar, or a similar small transparent jar (article No. 16), equipped with a metal screw cap closure can be used as a reservoir for the water supply for the wick of the wet bulb. The decorative coating should be removed from the outer flat surface of the screw cap and the underlying metal tinned with solder. The screw cap is then sweated with solder to the small end of the 1 by ¼-inch bushing (article No. 6). A ¼-inch hole is drilled through the screw cap in line with the ¼-inch pipe-size opening of the 1 by ¼-inch bushing. The edges of the ¼-inch hole should be made smooth and then be well tinned with solder in order to prevent the formation of rust that might be deposited on the wick of the wet bulb.

The 1- by ¼-inch bushing, attached to the screw cap, is connected to the bottom outlet of the cross (article No. 5). When the water reservoir is used with the moisture tester it is necessary that the wick attached to the wet-bulb thermometer be of sufficient length to pass through the 1- by ¼-inch bushing and to rest on the bottom of the glass jar. The water reservoir should be half filled with clean water.

Care should be exercised in handling the moisture tester, so that excess water does not drain into the body of the tester. A small plug of lint cotton *lightly* inserted between the wick and the screw cap will aid in preventing drainage of water from the reservoir into the body of the moisture tester. The wick of the wet-bulb thermometer must be kept moist while using the instrument in order to obtain accurate wet-bulb thermometer indications.

SEED-COTTON MOISTURE TESTER CONSTRUCTED OF PIPE FITTINGS FOR THE USE OF STEEL-STEM, BIMETALLIC, DIAL-INDICATING THERMOMETERS (ILLUSTRATED IN FIGS. 5, 6, AND 10)

Bill of Material

All pipe fittings to be either brass or malleable galvanized iron.

Quantity	*Article*	*Fig. 10, article No.*
1	⅜-inch pipe, 12 inches in length, only 1 end threaded	1
1	Machine bolt, 7/16 by 2½ inches, cut threads, or 7/16-inch diameter rod	2
1	Shoulder bushing, 1 by ⅜ inch, or if not obtainable use the following size bushings for 3 reductions from 1-inch to ⅜-inch pipe size:	3
	1 bushing, ½ by ⅜ inch.	
	1 bushing, ¾ by ½ inch.	
	1 bushing, 1 by ¾ inch.	
1	90° elbow, 1 inch	4
3	T's, 1 by 1 by 1 inch	5
3	Close nipples, 1 inch, 1½ inches in length	6
1	Long nipple, 1 inch, 3 inches in length	7
2	Long nipples, 1 inch, 3½ inches in length	8
1	Shoulder bushing, 1 by ¼ inch.	9

If this fitting is not obtainable substitute a 1 by ¼-inch square head plug and drill a ¼-inch diameter hole through the center of its head. (The use of separate bushings to obtain a 4-step reduction from 1-inch to ¼-inch pipe would place the source of water supply for the wick at too great a distance below the end of the thermometer.)

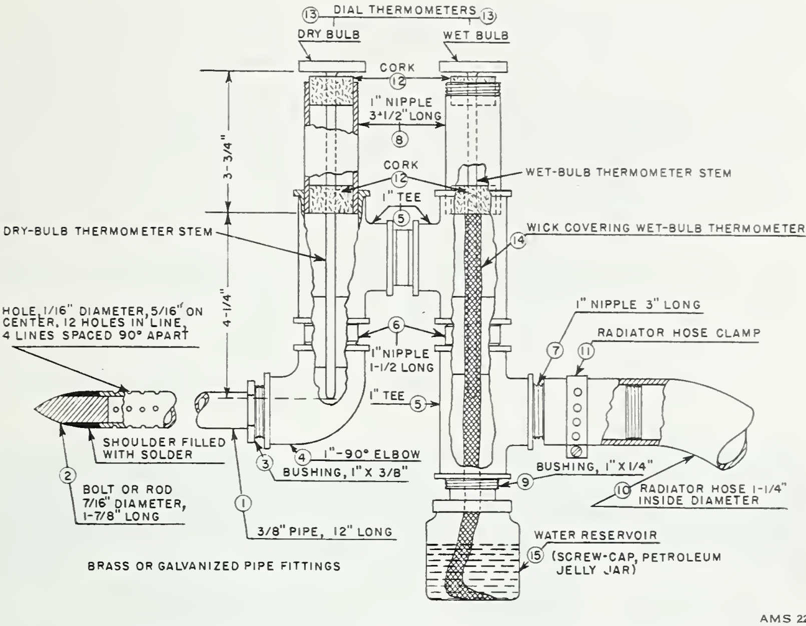


FIGURE 10.—Drawing of seed-cotton moisture tester illustrated in figures 5 and 6.

ACCESSORIES

	Solder.	
1	piece Automobile radiator hose, $1\frac{1}{4}$ inches (inside diameter) by 6 inches in length	10
2	Hose clamps, automobile radiator hose	11
4	Corks or rubber stoppers	12
2	Weston-type dial-indicating bimetallic steel-stem thermometers, 8-inch stem, temperature range 0° to 180° F., or 0° to 220° F. The thermometers should be obtained in matched pairs	13
	Wicks for wet-bulb thermometer stem	14
1	Small glass jar, with metal screw-cap closure	15
1	Vacuum cleaner, portable, hand-type.	

Specification for Construction and Assembly

AIR-INLET TUBE

This air-inlet tube is similar to the air-inlet tube described in the specification for construction appearing on page 18.

HOUSING FOR THERMOMETERS

Make airtight connections of the fittings 3, 4, 5, 6, 7, 8, and 9, in the order illustrated in figure 10.

It is advisable to ream or file the inner edges of the nipples so that the openings at the ends have the same diameter as the bore of the nipples.

The four cork bushings (article No. 12) should be cut or filed for a snug fit in the nipples (fittings 8) housing the thermometers (article

No. 13). The corks inserted in the lower ends of the nipples should be flush with the edges of the nipples. Each cork should have a hole bored, drilled, or burned accurately through its center for the insertion of the stems of the thermometers. The thermometer stems should be passed through the holes in the corks without applying pressures great enough to bend the stems. Wetting the thermometer stems with water before inserting them into the holes in the corks will aid their passage through the holes. If the holes in the corks are found to be oversize, lint cotton should be packed between the thermometer stems and the cork to minimize leakage of air at the thermometer stems.

The lower portion of the thermometer stems project not less than 4 inches from the cork bushings at the ends of the nipples, and they should clear the inner surfaces of the pipe fittings.

The thermometer housed in the nipple connected to the **T** nearest the tip of the moisture tester is designated the "Dry-bulb thermometer." The thermometer housed in the nipple connected to the second **T** is designated the "Wet-bulb thermometer."

WATER RESERVOIR

The water reservoir (articles Nos. 9 and 15) is similar in construction to the water reservoir described on pages 19 and 20.

PREPARATION OF THE WET-BULB THERMOMETER FOR USE

The wet-bulb thermometer is prepared for use in the following manner: A tubular wick is smoothly fitted around that portion of the thermometer stem projecting from the nipple, and it is brought into contact with the cork bushing. The tubular wick is secured to the thermometer stem by binding and tying close to the cork bushing with strong fine cotton or silk thread.

The moisture tester is made ready for use by connecting the nipple that houses the wick-covered wet-bulb thermometer to the upper rear **T**. The loose end of the wick is passed through the holes of the 1 by ¼-inch bushing (article No. 9), and the screw cap jar closure. The bushing is then connected to the lower end of the lower **T**. The water-reservoir jar should be half filled with clean water and attached to the screw cap closure. To hasten the rate of water saturation of the dry wick it is advisable to wet it thoroughly before the thermometer nipple is screwed into position. Care should be exercised in handling the moisture tester that excess water does not drain into the body of the tester. A small plug of lint cotton *lightly* inserted between the wick and the screw cap will aid in preventing drainage of water from the reservoir into the body of the moisture tester. The wick of the wet-bulb thermometer must be kept moist while using the instrument in order to obtain accurate temperature indications.

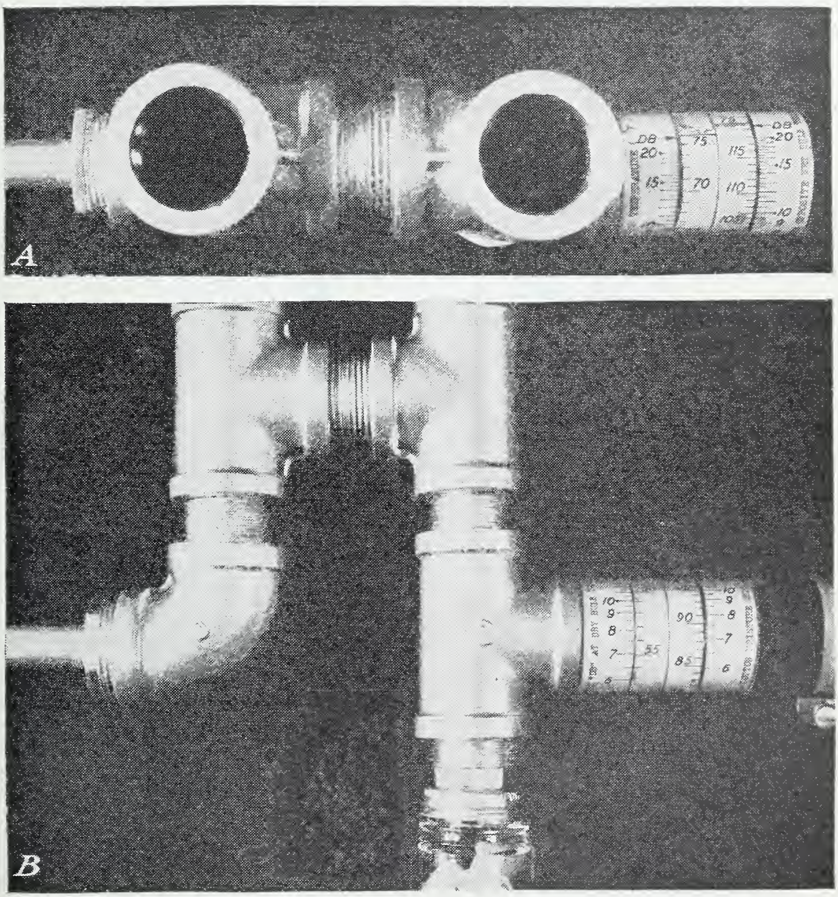
The extension of the wick below the end of the stem of the wet-bulb thermometer into the path of the air passing through the moisture tester, provides a means for equalizing the temperature of the water supplied to the wet-bulb thermometer with the prevailing temperature of the air passing through the moisture tester. Steel-stem thermometers require a longer time interval of response to change in temperatures than is usual for glass-bulb mercury thermometers.

The steel-stem thermometers, although not subject to the same degree of breakage in handling as are glass thermometers, are not designed to withstand rough handling.

CONSTRUCTION OF THE MOISTURE-CONTENT CALCULATOR (ILLUSTRATED IN FIGS. 11 AND 12)

Bill of Material

Quantity	*Article*
1	Extra-long pipe nipple, 1-inch, 5 inches in length.
6 inches	Pipe, 1¼-inch size for mounting of the calculating scales.
6 inches	Automobile-radiator hose, 1⅜-inch inside diameter (optional).
	Moisture-content calculating scales illustrated in figure 12.
	Suitable adhesive for affixing the calculating scales to sections of radiator hose, or to sections of 1¼-inch pipe.
	Transparent cellulose tape to cover and protect the calculating scales, preferably 1 inch in width.



AMS 2224

Figure 11.—Cylindrical-scale moisture calculator for use with testers in determining moisture content of seed cotton from wet-bulb and dry-bulb thermometer readings: *A*, plan view; *B*, a side view.

Specification for Construction and Assembly

The cylindrical drums on which the calculating scales are mounted are cut either from 1¼-inch pipe or from 1⅜-inch radiator hose. The use of 1¼-inch pipe in construction of the three cylindrical drums is recommended because of its rigidity. The radiator hose, owing to its flexibility and frequent lack of uniformity in wall thickness may cause misalinement of the calculating scales during use, with consequent error in moisture readings.

The three cylindrical drums, or sections, on which the calculating scales are mounted may be cut from the 1¼-inch pipe with a lathe or a hacksaw. The edges should be smoothed with a file, and the inside of the sections may need to be filed slightly at the pipe seam to make them round. The sections may be cut from a length of automobile-radiator hose having an inside diameter, or bore, of 1⅜ inches, if a hose is available in which the wall thickness is fairly uniform throughout the circumference. Two of the cylindrical sections are cut ¾ of an inch in width; and the third, or central section, is cut 1 inch in width. Care should be exercised in cutting the sections so that the edges of each section will be smooth, of uniform width throughout, square with the outer cylindrical surface, and parallel to each other.

The paper calculating scales illustrated in figure 12 are cut apart on the lines marked "cut" and are affixed to the cylindrical-drum sections of 1¼-inch pipe or radiator hose, with rubber cement, gasket cement, transparent quick-drying cement, or any other adhesive that does not contain water and will not cause staining or expansion or contraction of the paper on which the scales are printed. The paper calculating scales can be protected from surface soil and wear with a layer of transparent cellulose tape. This tape may be obtained from stores dealing in stationery supplies.

The prepared cylindrical sections of the moisture calculator scales are mounted for use on a 1-inch nipple, 5 inches in length. This 5-inch-long nipple replaces the 3-inch-long nipple specified for the outlets of the various types of moisture testers. The nipple serves as a bearing surface for the three cylindrical scales of the moisture calculator in addition to being the means of attaching the automobile radiator hose that connects the vacuum cleaner to the moisture tester.

The three scale sections should be slipped over the 5-inch-long nipple and the freedom of rotation of the sections on the nipple noted. If the sections fit too loosely, the diameter of the nipple can be increased or built up with gummed paper or other suitable material, affixed to the outer surface of the nipple. The central 1-inch-wide section should rotate under moderate pressure without losing its concentricity with respect to the nipple on which it is mounted. The two outer sections are concentrically fitted tightly to the nipple and cemented in place so that they cannot turn, *after* the scale sections have been placed in alinement.

The three scale sections of the calculator must be mounted on the 5-inch-long nipple in the same relative position in which they are placed in figure 11 *A*, illustrating the 5-inch-long nipple and moisture calculator connected to a moisture tester. In order to use the moisture calculator when the dry-bulb reading is found to be on one

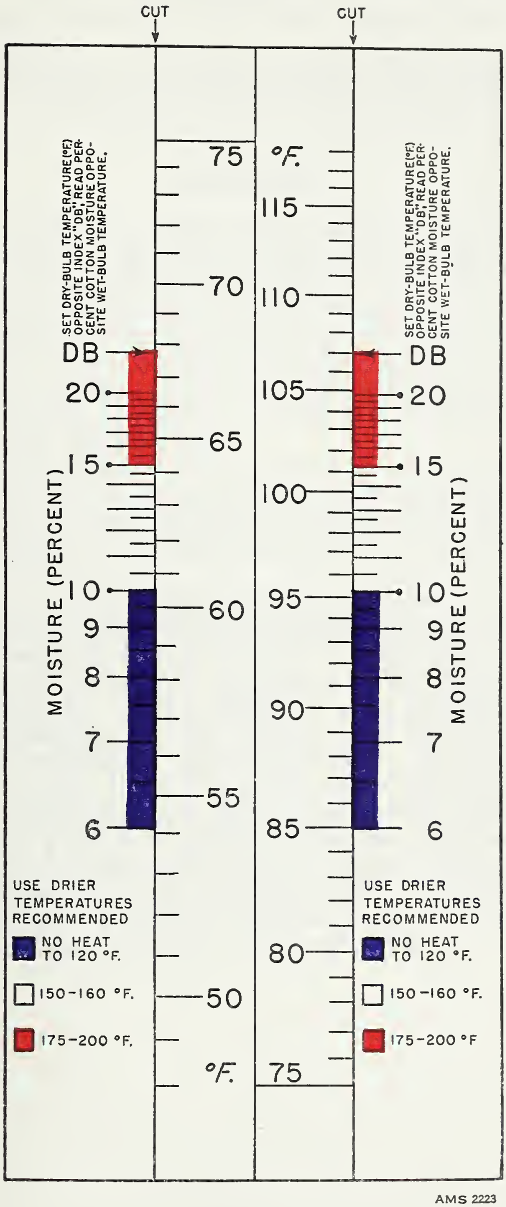


FIGURE 12.—Calculating scales for use in making the cylindrical direct-reading moisture calculator illustrated in figure 11.

edge of the center scale and the wet-bulb reading on the other edge, it is essential that each of the two outer moisture scales be set so that its index DB is directly opposite a 75° F. line on one edge of the center scale before the outer scale drums are cemented fast to the 5-inch nipple.

Allow a minimum of clearance between each fixed outer scale section and the center scale section for ease of rotation of the center scale section.

SUMMARY

A method and several devices are described and illustrated for determining, relatively quickly and easily, the average moisture content of seed cotton in bulk, as delivered to a cotton gin. This method is intended primarily for use in testing the degree of and the uniformity of moisture content of seed cotton as a means of indicating whether or not a load of seed cotton falls within certain accepted limits of proper moisture condition for good ginning; and in promoting more efficient operation of driers and ginning equipment for handling damp or wet seed cotton.

The psychrometric moisture tester, the moisture-conversion chart, and the moisture-calculator scale, when used in conjunction, readily provide a means of ascertaining the equivalent moisture content of seed cotton as based on the relative humidity of the air pervading the mass of material.

No heating or weighing of seed-cotton samples is required by this method of moisture testing, thereby eliminating two time-consuming and laborious operations. The use of a prepared conversion chart or special moisture calculator provides a method that is more rapid and practicable than others available to ginners today.

The moisture-testing devices described are relatively inexpensive, are of simple construction, and do not require precision methods of manufacture or assembly. Detailed specifications and bills of material for the construction of each of the several types of moisture testers, and of a moisture-content calculator are presented. The estimated cost of construction materials, and supplementary apparatus required for each type of moisture tester is approximately $25. Variations in local prices of materials will, of course, influence appreciably the total cost of the completed devices.

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